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REPORT ON WATER QUALITY IN VARTY LAKE

1972

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Ministry
of the
Environment

The Honourable
James A. C. Auld
minister

Everett Biggs
deputy minister

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REPORT ON WATER QUALITY

in

VARTY LAKE

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and its surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry:

1. Evaluation of existing waste disposal systems and enforcement of

repairs to those found to be unsatisfactory;

2. Research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal;

3. Evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Varty Lake is one of a series dealing with the water quality aspects of the recreational lakes studies in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Varty Lake in 1972 in May, July and October to evaluate the present status of the water quality with respect to bacteria, algae and aquatic plant growth. Plant nutrient and dissolved oxygen concentrations in the surface and bottom waters were determined.

Varty Lake, located in the County of Lanark, lies in the Napanee Plain and is part of the Napanee River watershed. It is a shallow, flat bottom lake with a mean depth of 1.4 meters (4.5 feet). Its triangular shape covers 6.0 kilometers (2.4 square miles) creating approximately 18 kilometers (11 miles) of relatively flat low-lying shoreline. There are approximately 113 cottages and one campground on the lake. Due to the combination of low-lying land and insufficient soil cover, much of the shoreline can be considered unsuitable for installation of standard sub-surface septic tank systems.

Generally, Varty Lake was within the TC and FC MOE criteria for all stations on the lake during the three surveys conducted. The FS criteria was exceeded during the July survey especially in the northern-most area of the lake. However, since a significant, concomitant TC and FC increase did not occur in this area, these high FS levels are considered to have originated from natural sources.

The lake is moderately hard with no unusual mineral characteristics. Temperature and dissolved oxygen concentrations were uniform throughout the shallow depth of the lake. Nitrogen and phosphorus concentrations were

moderately high with large seasonal variations probably brought about by excessive plant growth and its subsequent decay.

Varty Lake shoreline was heavily overgrown with aquatic plants including at least seven dominant species.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- density and species of aquatic plants
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most

disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

The growth of weeds along the shore was noted during the surveys. Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from May 22 to 26, from July 16 to 20 and from October 21 to 25.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over five consecutive days at each station are regarded

as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and on the first, third and fifth days at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Twenty-five bacteriological samples sites were established over the whole lake. Chemical samples were collected at one outlet station and at two mid-lake stations. In addition to these surface samples, chemical and bacteriological samples were taken from the bottom water at the mid-lake stations. Aquatic plant samples were collected in areas representative of sparse, medium and dense growth.

Field Tests

The temperature and dissolved oxygen values were measured at the deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc. (Figure 1). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Secchi Disc Reading

Clear, algae-free lake:
Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake:
Secchi disc readings tend to be less than 3m (9 feet).

2 times Secchi disc reading

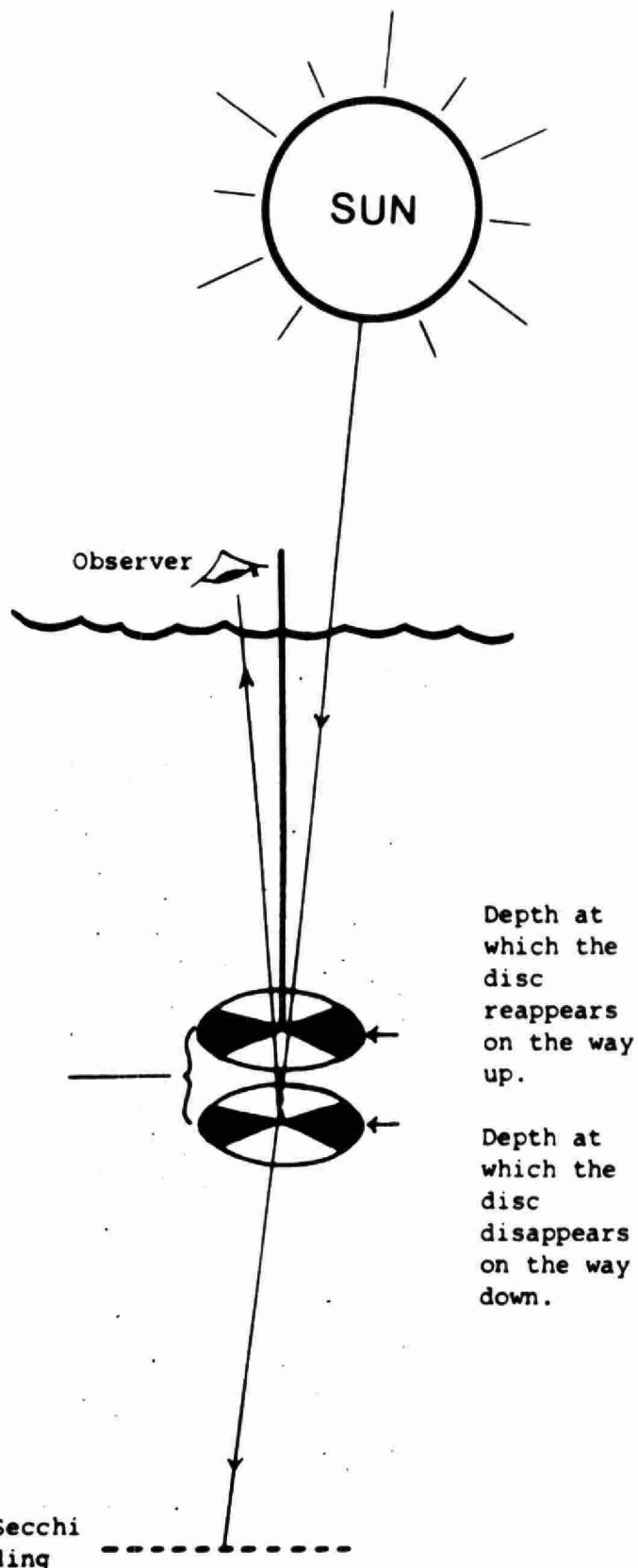


FIGURE 1: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY.

be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm-blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denotes the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that do not require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is used as a measure of the general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

Total and soluble phosphorus were measured in bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples.

The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the bottom water samples. They are particularly important in bottom waters since nitrogen is regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the lighted surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of the illuminated zone as it filled. The sample was then representative of the average number of algae through the depth of the surface waters.

DESCRIPTION OF THE VARTY LAKE AREA

Lake and Soil Characteristics

Varty Lake is located in Camden Township, County of Lennox and Addington and is approximately 16 kilometers (10 miles) north of the Town of Napanee. The lake lies in the Napanee plain region which consists of Trenton, Black River limestone bedrock covered by a one to two foot overburden. The immediate landscape surrounding Varty Lake is flat to undulating. Generally, the undulating areas are well-drained and are covered by Farmington loam type soils while the flat areas which are poorly drained are covered by Piccadilly loam, Otonabee loam, Moscow clay complex, muck and marsh type soil.

Varty Lake lies north-south and has an inverted triangular shape. The lake has a maximum length of 6.0 kilometers (3.8 miles) and a maximum

width of 3.3 kilometers (1.4 miles). The water surface area is 6.1 square kilometers (2.4 square miles) surrounded by 17.9 kilometers (11.0 miles) of irregular shorelines. The lake is very shallow with a maximum depth of 3.7 meters (12 feet) and a mean depth of 1.4 meters (4.5 feet). Varty Lake drainage basin, 22 square kilometers (8.7 square miles) in area lies in the Napanee River watershed. There are no apparent inlets and the only outlet is Varty Creek which flows into the Napanee River. The area surrounding Varty Lake is covered with a medium growth of a mixed forest consisting of white pine, cedar, sugar maple, burr oak, beech and basswood.

Shoreline Development and Water Usage

The type of drainage of the shoreline soil has, to a large extent, determined the development pattern of the approximately 113 cottages on Varty Lake (Figure 2). All of these cottages have road access. Most of the cottages use the lake as their source of domestic water supply. Recreational uses of the lake include boating, swimming, angling and duck hunting.

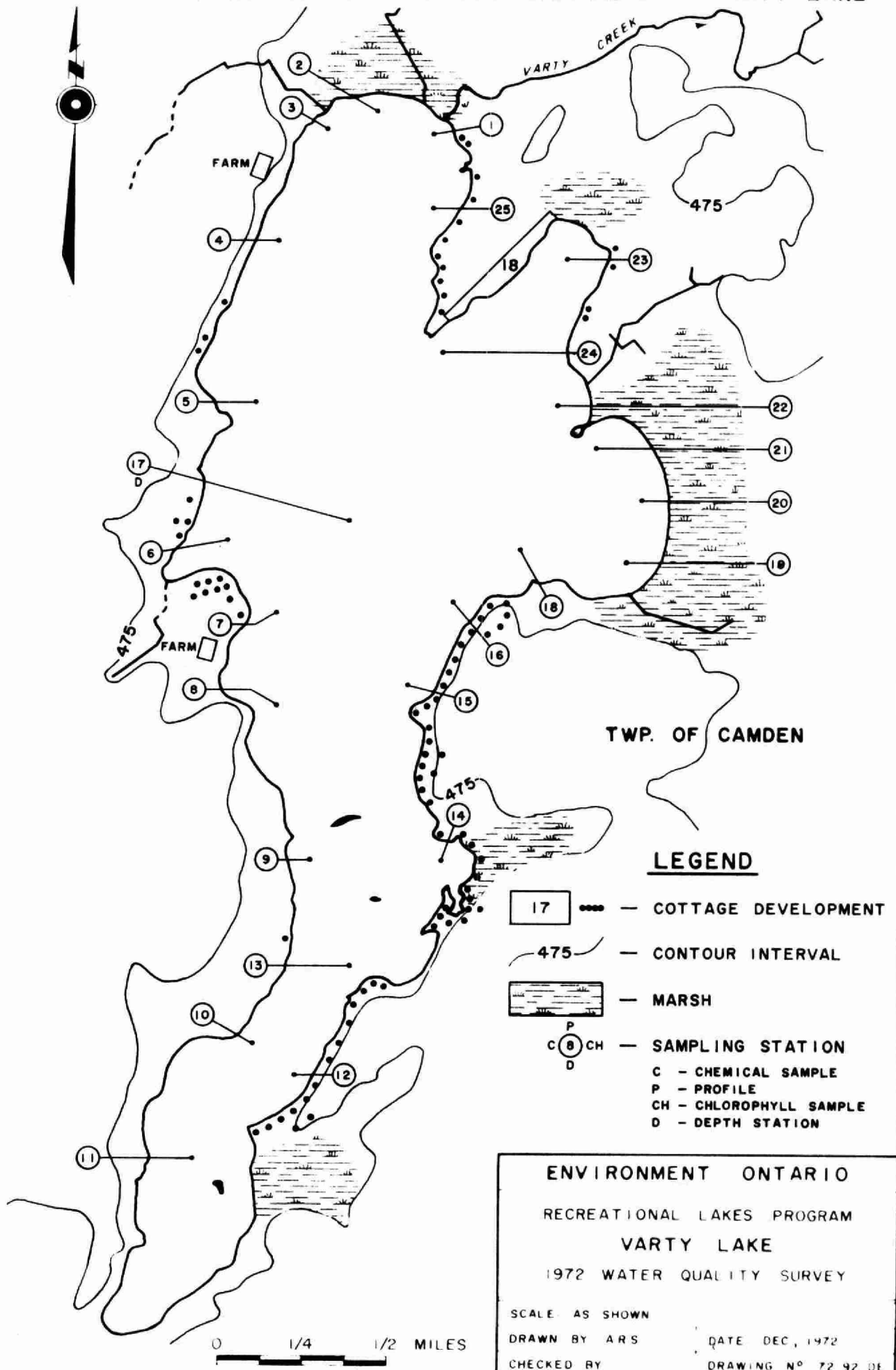
There are no direct discharges of wastes into Varty Lake from communal or municipal sewage treatment facilities. There does not appear to be any pollution from the operation of existing municipal solid waste disposal sites.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the

FIGURE 2 - COTTAGE DEVELOPMENT AND CONTOURS OF VARTY LAKE



analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

The three surveys conducted in 1972 revealed that Varty Lake, with the exception of fecal streptococcus (FS) densities around the north-west portion of the lake during the summer, was well within the total coliform (TC) and fecal coliform (FC) Ministry of the Environment Criteria (MOE 1972) which states: "Where ingestion is probable, recreational waters can be considered impaired when the TC, FC, and/or FS geometric mean density exceeds 1000, 100 and/or 20 per 100 ml, respectively...." (1)

In May, the TC, FC and FS geometric mean levels were 34, 1 and 1/100 ml respectively, well below the MOE Criteria (Figure 3). TC and FC mean levels were homogeneous for all stations throughout this survey while the area with moderate cottage development near the south-east corner of the lake displayed a higher FS mean of 3/100 ml.

The July survey revealed that all stations were homogeneous with TC and FC mean concentrations of 193 and 1/100 ml respectively (Figure 4). Although mean levels at all stations were within the TC and FC MOE Criteria, individual stations showed TC counts which fluctuated widely from day to day. The FS mean for the majority of stations (Group A) was 3/100 ml while the swampy area at the north end of the lake (Group B) had a high mean of 132 FS/100 ml, exceeding the criteria several fold. Since the TC and FC levels

(1) Guidelines and Criteria for Water Quality Management in Ontario. MOE 1972

did not increase in the Group B area, these high FS counts are probably a result of marsh drainage and should not constitute a health risk. Other stations within the influence of this marsh area at the northeast end of the lake (Stations 19, 20 and 23) displayed FS levels of 20, 115, and 23/100 ml respectively.

During the October 21-25 survey most stations on the lake had a TC mean of 102/100 ml (Group A). The moderate to heavy cottage development at the southeast corner of the lake (Station 14) revealed mean TC concentrations of 455/100 ml, appreciably higher than Group A (Figure 5). Both the Hartington and Bell-Rock Climatological stations recorded considerable amounts of rainfall during this period. TC populations on the first and second days of the survey were generally low. However, on the third, fourth and fifth days of the survey, during and following rainfall, marked progressive increases in TC densities occurred at most stations especially near the moderate to heavily cottaged area adjacent to the northern swampy outlet area (Station 1). These TC fluctuations can be attributed to the rainfall and the subsequent runoff carrying contamination into the lake.

The lake was homogeneous for FC and FS with low geometric means of 1 and 4/100 ml respectively. At no time during this survey did FC densities exceed the criteria. On an individual day basis, however, FS concentrations fluctuated considerably and were very high on the third day of the October survey.

Standard Plate Count (SPC) levels at the mid-lake profile station (Station 17) were obtained during the three surveys. In May, SPC mean densities were 4300/100 ml while mean levels during the July and October surveys were 1300 and 2311/100 ml respectively.

FIGURE 3 - DISTRIBUTION OF BACTERIA IN JUNE

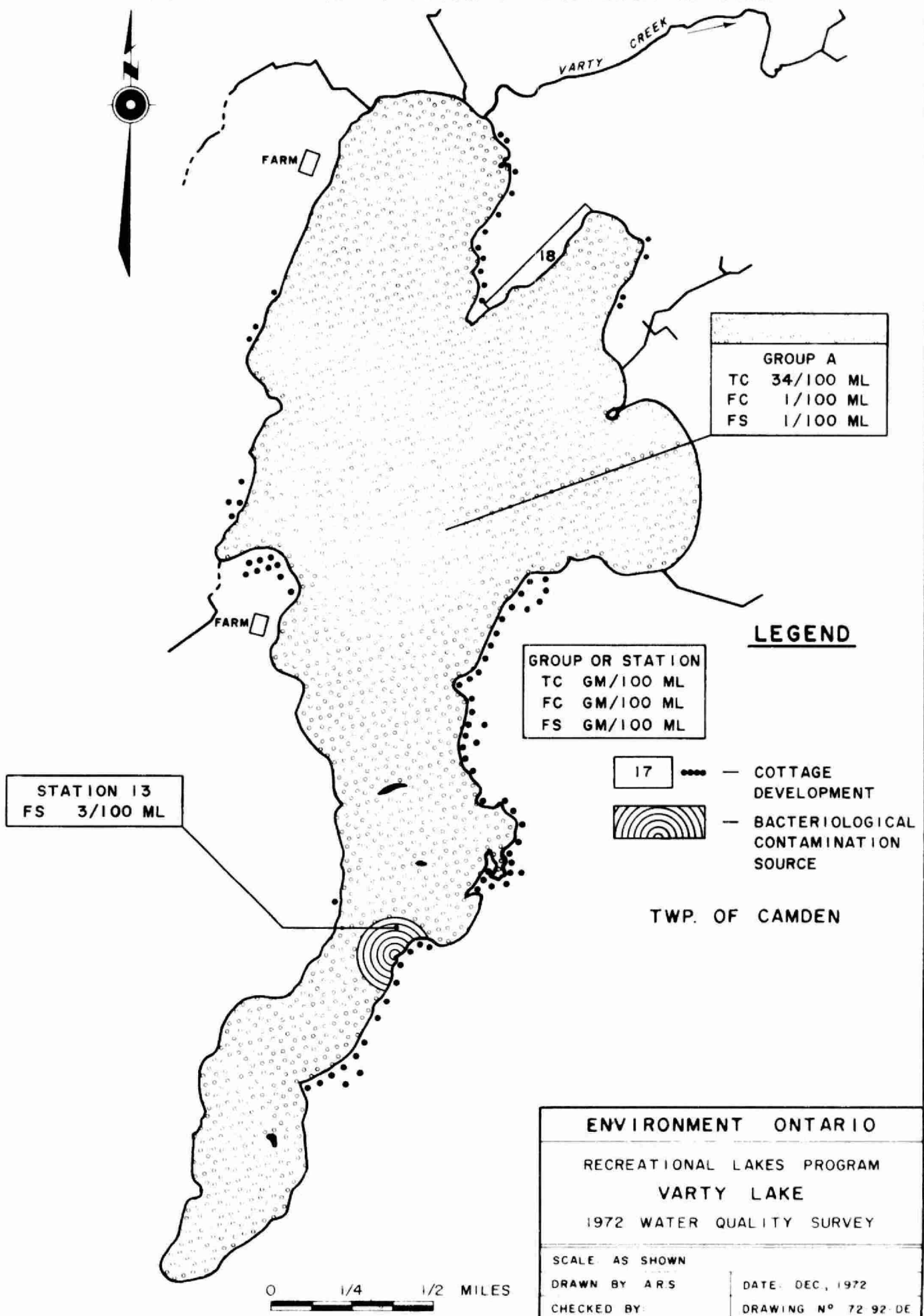


FIGURE 4 - DISTRIBUTION OF BACTERIA IN JULY

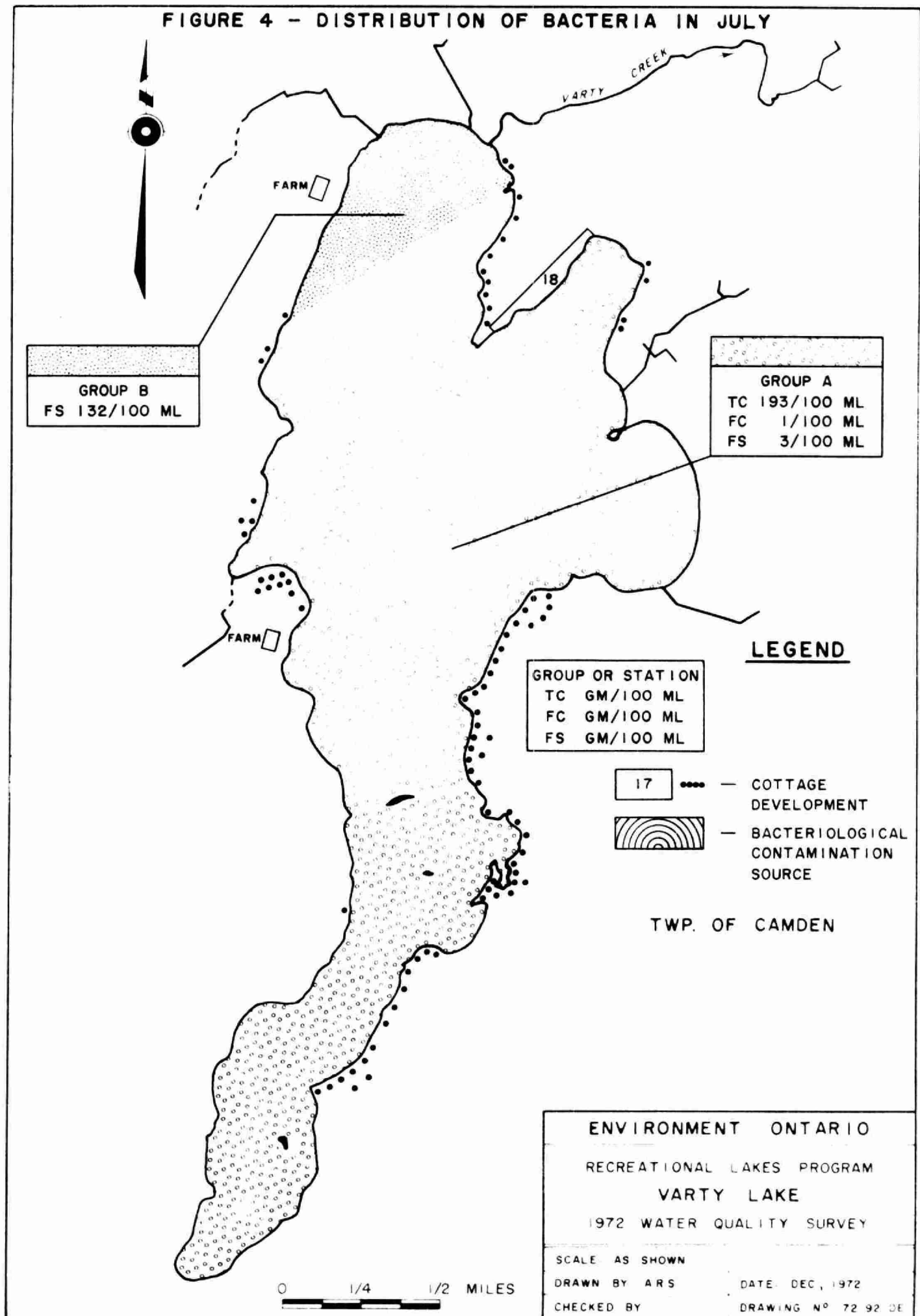
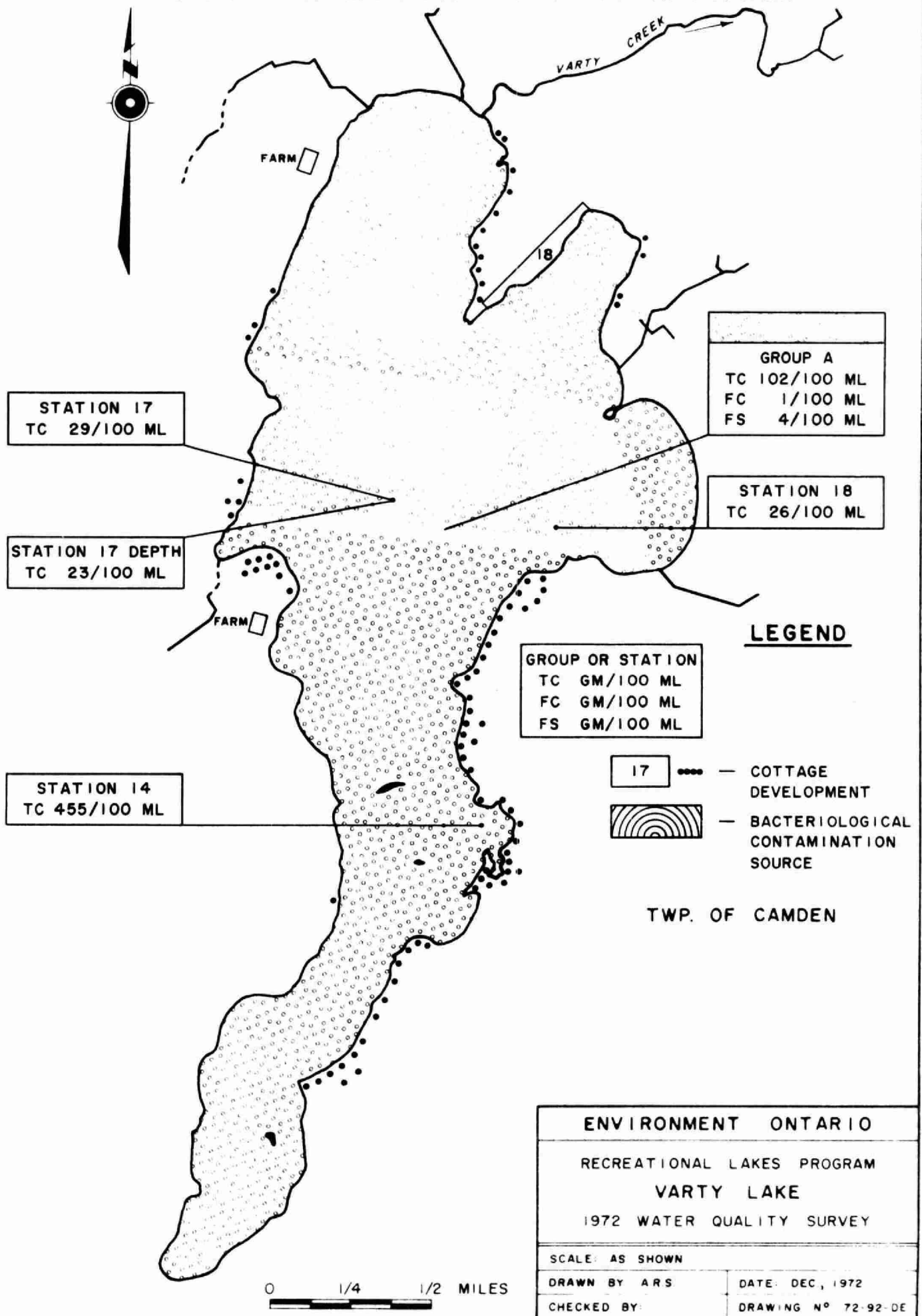


FIGURE 5 - DISTRIBUTION OF BACTERIA IN OCTOBER



Chemistry

Varty Lake is a moderately hard water lake with hardness ranging from 96 to 140 mg calcium carbonate per litre. Over the three surveys, alkalinity and conductivity correlated well with variations in hardness and along with data on pH and chloride concentration, indicate that no unusual mineral characteristics were present in the lake.

Overall Ranges:

Alkalinity	-	82-107 mg/l as CaCO_3
Conductivity	-	186-226 $\mu\text{mhos}/\text{cm}^3$
Chloride	-	2 - 4 mg/l
pH	-	7.2 - 8.7 units

Some seasonal trend was evident with highest pH values coinciding with lowest alkalinity, hardness and conductivity during the mid-summer survey. The mid-summer values are most likely the result of uptake of inorganic carbon by the aquatic plant community.

Temperature and dissolved oxygen concentrations were uniform throughout the water column during each of the three surveys. During the May survey, the temperature and dissolved oxygen ranged from 20.0 to 22.3°C and from 92% - 107% saturation respectively. The July water temperatures were higher and ranged from 23.5 to 26.8°C; however, the dissolved oxygen was lower with percentage saturations ranging from 64 to 100%. These lower dissolved oxygen concentrations could be related to a high rate of decomposition of organic matter at the warm summer temperatures. By October the lake temperature had decreased to 5-6°C while dissolved oxygen ranged from 90 to 105% saturation.

Surface and bottom water samples collected for chemical analyses differed little in concentration of constituents – further indicating the well-mixed nature of the shallow waters of the lake. The total phosphorus concentration ranged from 10 to 36 ug/l except for one sample (95 ug/l) at Station 27. The total Kjeldahl nitrogen concentration ranged from 480 to 740 ug/l except for the above-mentioned sample which had a concentration of 920 ug/l. Iron concentrations were low (less than 50 ug/l) during all three surveys.

Highest concentrations of phosphorus were present during the spring survey and were probably brought about by release from decaying vegetation under winter ice cover. Highest amounts of suspended algae (as measured by chlorophyll a) were present during the spring survey as well. The decrease in total phosphorus at all three in-lake locations from spring to fall was associated with a decrease in chlorophyll a as follows:

Mean concentrations of Phosphorus (P) and Chlorophyll a (Chl a) in ug/l during the three surveys

	Station 17		Station 26		Station 27	
	<u>P</u>	<u>Chl a</u>	<u>P</u>	<u>Chl a</u>	<u>P</u>	<u>Chl a</u>
Spring	26	4.7	30	3.1	45	2.8
Summer	20	2.3	17	2.1	25	1.9
Fall	23	1	13	1	12	1

Assimilation of phosphorus by the abundant aquatic plant growth in the lake was probably the main cause of the phosphorus depletion. Hence, the growth of suspended algae was limited to spring and early summer. Light penetration was to the bottom of Varty Lake during all three surveys.

Aquatic Plants

Varty Lake is heavily overgrown with aquatic plants and the shallow water is no doubt a dominant factor contributing to the dense and widespread distribution of several species. Nine genera are represented, from which seven different species were identified (Table 1). Many of the plants could only be identified to genus because they lacked the fruiting or flowering structures necessary for complete identification. Figure 6 outlines the location and extent of the weed beds and list the plants found in each area. While this figure shows the distribution and total density of the plants, the density or dominance of any particular plant type was not determined. Figure 7 illustrates some of the more common plants found in Varty Lake. Control of plant growth (see page A-9) in the lake may become a necessary lake management tool in future years if a greater variety of recreational pursuits is to be utilized.

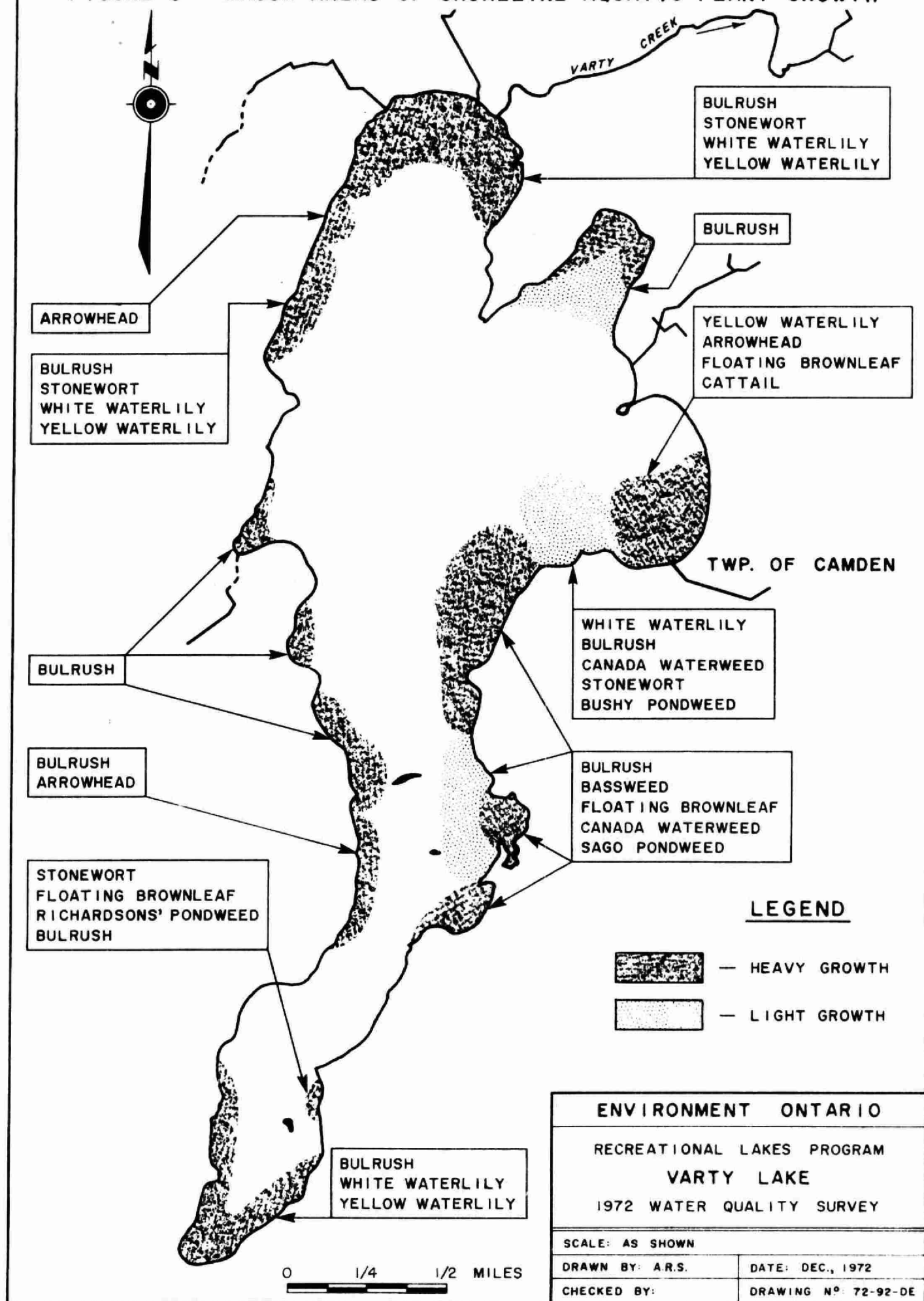
TABLE 1: Aquatic plants found in Varty Lake and their distribution.
For convenience the plants are divided into two categories:
(a) submergent - aquatic plants which live for the most part underwater and (b) emergent - plants which produce floating or aerial leaves.

Scientific Name (Genus, species)	Common Name	Distribution**
(a) SUBMERGENT		
<u>Chara</u> * sp.	Stonewort	V.A.
<u>Elodea canadensis</u>	Canada waterweed	V.A.
<u>Najas flexilis</u>	Bushy pondweed	C.
<u>Potamogeton amplifolius</u>	Big-leaf pondweed; Bassweed	C.
<u>Potamogeton natans</u>	Floating brownleaf	C.
<u>Potamogeton nodosus</u>	Floating-leaf pondweed	C.
<u>Potamogeton pectinatus</u>	Sago pondweed	C.
<u>Potamogeton richardsonii</u>	Richardsons' pondweed	C.
(b) EMERGENT		
<u>Nuphar</u> sp.	Yellow waterlily	A.
<u>Nymphaea</u> sp.	White waterlily	A.
<u>Sagittaria</u> sp.	Arrowhead	A.
<u>Scirpus</u> sp.	Bulrush	V.A.
<u>Typha</u> sp.	Cattail	A.

*Chara is technically an alga, but because it grows in long strands it is most often called an aquatic plant.

** V.A. - Very Abundant
A. - Abundant
C. - Common

FIGURE 6 - MAJOR AREAS OF SHORELINE AQUATIC PLANT GROWTH





ARROWHEAD



RICHARDSON'S PONDWEED



CANADA WATERWEED



BULLRUSH



FLOATING BROWNLEAF;



CATTAIL



STONEWORT

Figure 7: Photographs of some common aquatic plants found in Varty Lake.

INFORMATION OF GENERAL INTEREST TO COTTAGERS MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria do not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis but he may catch lesser infections of gastroenterities (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These virus infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will be used as food

by these organisms and will give rise, in turn, to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amount of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) **Boiling**

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) **Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine**

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) **Continuous Chlorination**

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) **Well Water Treatment**

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH per 10 ft depth of water		
Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.

Great Lakes Surveys Unit
Water Resources Branch
Ministry of the Environment
135 St. Clair Avenue West
Toronto, Ontario, Canada
M4V 1P5

